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Keding, Ralf; Jensen, Martin; Höche, Thomas; Yue, Yuanzheng

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Synthesis and properties of glassy mesoporous SiO₂ in the freshwater sponge Cauxi

R. Keding*¹, M. Jensen¹, T. Höche², Y.Z. Yue¹

¹Aalborg University, Denmark

²Leibniz Institut for Surface Modification, Germany

The freshwater sponge Cauxi was collected at the river bank of the Rio Negro at Praia Grande in the Amazon basin 60 km west of Manaus, Brazil. Detailed investigations show that amorphous silica is synthesized by Cauxi in aqueous solution under ambient conditions via biological catalysis. The high-purity amorphous silica is obtained as spicules (average diameter: 15.6 μm, average length 305 μm) that are cemented through junctions, thereby forming the skeleton of the sponge. After removal of organic components the spicules were investigated by differential scanning calorimetry and the glass transition temperature of the glassy phase was determined to 1400 K indicating a low alkali and water content. The inorganic part of the spicules consists of about 99.7 wt% SiO₂ and traces of CaO and Al₂O₃. Vacuum hot extraction experiments, transmission electron micrographs, small angle X-ray scattering as well as thermogravimetric investigations exhibit that such amorphous spicules themselves consist of a glassy phase and contain about 10 vol% mesopores (average diameter: 23 nm). The microstructure and the properties of the Cauxi skeleton are described here. The driving force for the glassy silica deposition is identified as the supersaturation of silica in the Rio Negro caused by a change in the pH value.